FOOD RESOURCES AND RESPONSIBILITY: A TALE OF TWO WORLDS

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Rich Nations and Poor Nations

The proliferation since World War II of multilateral, bilateral and non-governmental agencies devoted to technical assistance and economic development has brought with them a vocabulary of new nomanclatures. The terminological descriptors for the poorer, non- or weakly-industrialized members of the industrial community are many and have changed over the years. While there is clearly an inherent risk in assembling such a heterogeneous conglomeration of nations under one single heading, there is little doubt, as illustrated by the Brandt Commission in its two recent publications, that despite international and national disparities, the rich developed nations of North America, Europe and Oceania have access to far greater opportunities and resources than most of their contemporaries in Africa, Asia, Latin America and most of the Middle East.

Table 1 illustrates the extent of these differences. The developed countries, with only a little over a quarter of the world's population, use more than 60% of the world's commercial energy; control more than 90% of the world's research; and publish roughly 90% of all its books. The developed countries consume 50% more food calories per capita than the less developed. Exports from the developed to the developing countries exceed US $300 billion, representing slightly over one-third of these countries total exports. Roughly one industrial job in six in the United States depends on exports to the Third World.

Food and Populations

Table 2 shows that by the end of the decade the developing countries population will have increased from roughly three-quarters to four-fifths of the world's total. These numerical averages do not reveal some important demographic changes that are also occurring. The populations of the developed countries are progressively aging; those of the developing countries are relatively younger. During the past five years the proportion of Canadians under the age of 15 has decreased by 7% while those over 65 years of age has increased by 18%. The present median age in Canada is 29 years and will probably reach 36 by the end of the century. From extrapolation of present trends, and if present retirement patterns do not change, by the end of the century there will be only two fully employed workers for each retired person in the United States.

Older people have smaller appetites than those who are young and active. Consequently, per capita and possibly total food demand will decline among such major food producers as Canada, the U.S.A., Australia and New Zealand while the poorer nations with larger younger populations will inevitably

demand more. Throughout the world, the proportion of urban to rural populations is continually increasing. The urban population of Latin America may well exceed 60% by the end of the century. The inevitable conclusion is that rural farming communities will need to produce increasingly more food than they need for their own subsistence.

People and Land

Table 3 presents the average area of arable land per capita in the developed countries, the Soviet bloc and less developed countries. The continuous decline in arable land, from causes discussed later, should excite serious concern in the mind of every politician and policy maker. If, as the Table suggests, there will be an average of only 0.25 hectares for every person in the world by the end of the century, assuming present average yields of cereal grains, 0.25 hectares will produce roughly 1½ times the calorie requirements of a working adult. Allowing for losses during harvesting, post-harvest storage, processing and food preparation, 0.25 ha provides the bare minimum caloric requirement. However, since the assumption is based upon 0.25 ha of cereals, it allows for no production of legumes, other complementary foods or the raising of livestock. If massive malnutrition is to be avoided, significant increases in yields per unit area per year will be needed in those developing countries where arable land is forecast to drop to 0.19 ha/person.

Table 4 demonstrates the very serious situation in which certain countries may find themselves by the end of the century. In Egypt, with one of the highest population densities per arable hectare, IDRC is supporting a major program to try to bring large areas of the desert under the plough.

Production Patterns

Table 5 presents the general pattern of food production in the developing country regions over the decade of the 70s in comparison with the first five years of the 60s. While all regions increased their total output, only Latin America and East Asia demonstrated significant improvement in per capita production. African countries, many of which were more than self-sufficient in subsistence food production before 1950, show an overall serious decline in per capita production. Of the nine members of the Southern African Development Coordination Conference (SADCC), only Zimbabwe produces more food grain calories than its overall population consumes. Nigeria appears to have invested much of its oil revenue in increased food imports rather than in improving its indigenous agriculture. Though many countries in the Sahel and other dryland areas of Africa suffered excessively from the drought years of the early 1970s, and all of them have been greatly stressed by the high price they are forced to pay for imported oil, many could be more productive if a higher priority were given to agriculture; if farmers were given greater incentives to produce and, most important, if the developed countries were more reasonable in the terms of international trade.

Production and Importation

Table 6, based upon FAO projections, indicates that total production of virtually all basic foods will need to at least double by the end of the century. Figure 1 shows that over the decade all cereals increased by barely 37%, which falls short of the 100% increase needed over the next 20 years.

Table 7 throws further light upon the bleak prospects faced by many developing countries. Overall, the developing countries increased their imports of cereals roughly 2½ times between 1968 and 1978. The table does not

show that the developed countries enjoy a massive positive balance in their trade with the less developed. Exports annually from the developed to the developing countries exceed US $300 billion in value, of which the EEC enjoys $113 billion, US $84 billion and Japan almost $70 billion.

Inflation

Though all countries can complain of the detrimental effect of inflation upon their cost of living, Table 8 clearly shows that the developing countries have borne a disproportionate share of the inflationary burden. The high cost of oil, together with high interest charges upon borrowed capital has brought several developing countries close to bankruptcy. Their unhappy economies are being jeopardized further by restrictive trading practices by the wealthier nations who seek to increase their exports while reducing the quantities of and prices paid for commodities imported from their poorer neighbors.

Agriculture, Armaments and Aid

The impressive gains in food grain production achieved in such countries as India, the Philippines and Indonesia which have given priority to agricultural research and development, should encourage all other nations to increase their investment in agricultural research and development. As the data in Table 9 shows, this is not the case. Governments of both developed and developing countries seem more disposed to produce bombs than bread; to buy armoured tanks than agricultural tractors. The investment on armaments suggests a world of governments hell-bent towards universal self-destruction. A fraction of the annual cost of armaments if invested in agriculture would guarantee an adequate diet for all the developed countries well into the future.

Table 10 indicates the present order of priorities in the United States, a pattern not untypical of many developed and developing countries, one in which the U.S.A. is by no means alone.

In spite of the enormously favourable balance of trade enjoyed by the developed over the developing nations, the former seem largely indisposed to be generous in their overseas development assistance program. Though 0.7% of GNP has been the long accepted target for ODA by the OECD countries, Table 11 shows that relatively few come close to it. Though few European or North American countries offer a shining example of compassion for the less developed, the Eastern Soviet bloc's assistance for non-military purposes is so meagre as to be of little consequence.

International Agricultural Research

One of the more enlighted and encouraging initiatives over the past decade has been the establishment of and investment in the International Agricultural Research Centres (IARCs) which are supported financially by a consortium of donors, the Consultative Group on International Agricultural Research (CGIAR). The program began in 1971 with four IARCs: The International Rice Research Institute (IRRI) in the Philippines; the International Maize and Wheat Improvement Centre (CIMMYT) in Mexico; and two institutes devoted to tropical agricultural systems, one in Nigeria, the other in Colombia. In 1971 the total budget of the four Centres was about $10 M.

The CGIAR family now consists of 13 IARCs and related research activities supported by 20 bilateral, 11 international and multilateral agencies, and five foundations.

The extensive adoption by farmers of the high yielding wheat and rice types has been well publicized giving rise to the misleading concept of "A Green Revolution". Roughly one-third of all the land under wheat throughout the developing countries and one-third of all the rice land in Asia is planted with high yielding types. It is estimated that the value of the increase in wheat production attributable to high yielding types is in excess of US $3 billion annually. In India high yielding wheat is grown by 90% of the wheat farmers who plant more than 25 hectares and at least 50% of the farmers who grow wheat on one hectare or less.

According to some publicists who seem opposed to the philosophy and practices of the IARCs, international plant breeding programs are dedicated to a serious reduction in the quantity and diversity of the world's food crop germplasm. Tables 12 and 13 illustrate the enormous and expanding germplasm banks which the IARCs have collected and classified and from which they and national breeding programs in the developing countries can combine characters to produce higher yielding, disease resistant types adaptable to a wide range of agro-climatic conditions.

Figures 2 and 3 illustrate the remarkable progress made at IRRI in combining many desirable characters into a single genotype. One of the earliest high yielding varieties was IR8 which, as the figure shows, was derived from two parents and possessed a relatively limited range of disease resistance. By gene pyramiding and combining desirable characters from a large number of rice genotypes, IRRI produced IR36 characterized by a high yield potential together with resistance to several important pests and diseases.

Food and Energy

The high yielding types require optimum agronomic practices to achieve their full potential. Most productive agronomic practices call for significant inputs of energy both direct, in the form of farm machinery and irrigation equipment, and indirect, in the form of chemical fertilizers and pesticides. Though some optimistic writers have predicted that modern techniques of genetic manipulation will provide us with cereal grains which, like leguminous crops, can fix nitrogen in symbiotic relation with soil bacteria, such techniques, if ever realized, are still many years in the future. Chemical fertilizers are needed and will continue to be needed for the foreseeable future. As with many other resources however, a more equitable distribution of the world's energy resources with a fairer share going to the developing countries would generate greater agricultural production in many countries of Asia, Africa, the Near East and Latin America. Table 14 shows that in the developing countries 8% of the direct energy to agriculture is mechanical, while 92% comes from human effort and animal power. The direct energy used per capita in the developed countries is 18 times that of the developing countries.

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Though they have an urgent need for fertilizers, Table 15 shows the severe cost constraints imposed upon Caribbean banana producers by increased fertilizer prices. One of the most urgent needs of farmers in the developing countries is for adequate supplies of chemical fertilizers at prices they can afford.

In Canada, whose agricultural and production system is not untypical of most other developed countries, the total food chain from farm production through to human consumption, absorbs less than 18% of the total energy used commercially. Within the food chain, production accounts for 18%; processing, distribution, storage, transformation and utilization for 82%.

Land Loss

To supplement the greater food yields per hectare of land attainable by higher yielding types stimulated and sustained by suitable agronomic practices, more land throughout the world must be brought under cultivation. As Table 16 shows however, rather than bringing more land under the plough, 15 M ha of arable land are lost annually, almost half of it to urban and industrial spread.

As Table 17 shows, in both Australia and Canada good quality arable land represents less than 6% of the total national area. Unfortunately, in Canada, most of the arable land despoiled by urban and industrial sprawl was first class agricultural land of which we possess so little. Farm land that is buried under concrete and asphalt is utterly irretrievable, a sad fact which does not appear to be evident to a great many politicians and land use planners.

Post-Production Systems

Though investment in research and development to increase on-farm production is considerably less than is necessary in developing countries, the post-production system receives even less attention. The post-production system begins at the time and place the crop is harvested and ends where and when the food is eaten. Post-production systems in general suffer from inadequate investment and frequently from misapplied resources. Though much is spoken and written about "appropriate technology" and the "transfer of technology", frequently the two do not seem to coalesce. In general, technologies that adapt most appropriately as components of rural post-production systems are best developed where they are to be used and in close cooperation with those who are to use and benefit from them. In recent years agricultural scientists have come to realize that their research is most effectively applied when it begins with a comprehensive understanding of the farming communities who are intended to adapt and use the products of the research. Modern farming systems research starts therefore by determining the opportunities and constraints, the resources, and the physical, economic and social climates in which the farmers live and work.

A similar philosophical approach is necessary to the development of efficient post-production systems and to the elaboration of truly appropriate and applicable post-harvest technologies. There is little purpose in proposing the transfer of novel technologies for the manufacture of unfamiliar foods to rural industries which possess neither the resources with which to produce them, nor access to markets in which to sell them.

Agro-industrial Development

The linear approach to rural industrial development: starting in the laboratory, proceeding through a pilot plant, and eventually presenting a finished technology to rural industrialists, is more likely to end in disappointment and frustration than in technical and economic development. Though it requires more patience, more skill, and the need for the scientist and technologist to spend time away from their laboratory and pilot plant, it is unquestionably more reliable if technological development begins with the industries it seeks to serve, by determining the potential market for the products of those industries, the resources available to those industries, their opportunities for expansion or diversification and the many constraints by which all of these are conditioned. A thorough comprehension of these important factors is essential if rural agro-industrial development is to take place on a significant scale in developing countries. Agriculture and agriculturally based industries provided the leading edge of and motive force for economic development in most of the countries of Europe, North America and Oceania. Unquestionably they offer the greatest hope for economic development in many developing countries.

Malnutrition and Poverty

Malnutrition, historically and in the contemporary world, goes hand in hand with poverty. As poor people acquire income they spend it first on more food and later upon other manufactured goods and services. Since the vast majority of the poor people of the developing countries are rural people, it is through increased agricultural production and through the establishment of sound rural industries, that economic progress, opportunities for employment and the gradual elimination of malnutrition will result. This will come about when politicians and policy makers in both developed and developing countries recognize that an investment in agriculture is infinitely preferable to investment in armaments: that we all live in one world, a world in which we shall all survive and prosper, or all perish.

TABLE 1

RESOURCES 1980

	DEVELOPED	DEVELOPING
WORLD POPULATION (%)	27	73
WORLD AGRIC. PRODUCTION (%)	62	38
WORLD CEREAL PRODUCTION (%)	88	12
WORLD COMMERCIAL ENERGY (%)	62	38
ENERGY IN AGRIC. SYSTEMS (% NATIONAL CONSUMPTION)	17 - 30	60 - 90
AVERAGE DAILY CALORIES/CAP	3300	2200
ARABLE LAND 2000 AD (Ha/CAP)	0.46	0.19

TABLE 2

POPULATION

	1980		2000	
	10^9	%	10^9	%
WORLD	4.4	100	6.2	100
DEVELOPED	1.2	27	1.3	21
DEVELOPING	3.2	73	4.9	79

TABLE 3

ARABLE AREA PER CAPITA, ACTUAL AND PROJECTED (trend)

				PROJECTED	
COUNTRIES	1951-55	1961-65	1971-75	1985	2000
INDUSTRIALIZED	.61	.56	.55	.50	.46
CENTRALLY PLANNED	.45	.39	.35	.30	.26
LESS DEVELOPED	.45	.40	.35	.27	.19
WORLD	.48	.44	.39	.32	.25

NOTE: ARABLE AREA INCLUDES LAND UNDER TEMPORARY CROPS (DOUBLE-CROPPED AREAS ARE COUNTED ONLY ONCE), TEMPORARY MEADOWS FOR MOWING OR PASTURE, LAND UNDER MARKET AND KITCHEN GARDENS (INCLUDING CULTIVATION UNDER GLASS), AND LAND TEMPORARILY FALLOW OR LYING IDLE.

SOURCE: THE GLOBAL 2000 REPORT TO THE PRESIDENT, VOL. 2, THE TECHNICAL REPORT. PREPARED BY THE COUNCIL OF ENVIRONMENTAL QUALITY AND THE DEPARTMENT OF STATE.

TABLE 4

POPULATION PER ARABLE HECTARE IN SELECTED COUNTRIES, 1975, 1985 AND 2000 A.D.

ASSUMING NO CHANGE IN POPULATION GROWTH RATE

	Arable hectares (millions)	Population 1975 (millions)	Population per arable hectare 1975 (persons)	Annual Rate of natural increase 1965-75	Population 1985 (millions)	Population per arable hectare 1985 (persons)	Population 2000 A.D. (millions)	Population per arable hectare 2000 A.D. (persons)
Mexico	28	60	2	3.5%	85	3	136	5
Korea	24	34	14	2.0%	41	17	54	22
India	167	608	4	2.0%	741	5	983	6
China	129	823	6	1.7%	974	7.5	1241	10
Kenya	1.8	13	7	3.3%	18	10	28	15
Tanzania	6.1	15	2.5	2.8%	20	3.5	30	5
Egypt	2.9	37	13	2.3%	46	16	63	22
All LDCs	670	1900	3	2.5%	2400	3.5	3343	5

Sources:

Arable hectares from FAO Production Yearbook. Arable hectares includes land used for both annual and permanent crops.

Population levels and rate of natural increase from "Population Growth 1965-75" published by Population Reference Bureau, Washington, D.C.

Ratio of man to land extrapolated.

TABLE 5

FOOD PRODUCTION INDICES IN VARIOUS REGIONS OF THE WORLD (1961/65 - 100)

	TOTAL PRODUCTION			PER CAPITA PRODUCTION		
	1970	1975	1979	1970	1975	1979
WORLD TOTAL	123	135	147	107	108	110
DEVELOPING COUNTRIES						
LATIN AMERICA AND THE CARIBBEAN	129	152	173	107	110	113
AFRICA 1/	117	120	134	98	96	88
WEST ASIA	122	154	168	102	110	108
SOUTH ASIA	128	140	146	110	107	103
EAST ASIA 2/	129	155	175	108	116	120

1/ EXCEPT FOR SOUTH AFRICA

2/ EXCEPT FOR JAPAN

SOURCE: CGIAR SECOND REVIEW

TABLE 6

PRODUCTION INCREASES TO MEET
MINIMAL LDC NEEDS IN 2000 AD

		% INCREASE 1971-80
TOTAL CEREALS	X 2	37
COARSE GRAINS	X 2	31
ROOT CROPS	X 2	
VEGETABLES	X 2.5	
VEGETABLE OILS	X 2.5	
FRUIT	X 2.5	
MILK	X 2.25	
MEAT	X 2.5	

TABLE 7

NET TRADE IN CEREALS

(M. TONNES)

	1968	1978
NORTH AMERICA	49	113
AFRICA	(2.6)	(10.8)
LATIN AMERICA	1.4	(4.3)
N.EAST/W. ASIA	(4.4)	(14.0)
S.-S.E. ASIA	(11.8)	(11.1)
ALL LDCs	(17.6)	**(40.4)**
USSR GROUP	(0.4)	(28.7)

TABLE 8

COST OF LIVING INCREASES

	1971	1980
AVERAGE INFLATION RATE (%)		
DEVELOPED	5.3	12.7
DEVELOPING	4.5	19.2
AVERAGE INCREASE OF CONSUMER FOOD PRICES		
DEVELOPED	4.6	9.4
DEVELOPING	4.0	22.3

TABLE 9

ARMAMENTS VS. AGRICULTURAL INVESTMENT

($US BILLION)

	1980	1982	% INCREASE	$/CAPITA LDCs '82
INVESTMENT IN ARMAMENTS (WORLD WIDE)	450	650	44	200
AID FOR FOOD AND AGRICULTURE (BILATERAL & MULTILATERAL)	11	11	0	3

TABLE 10

U.S. GOVERNMENT INVESTMENTS IN R & D

$ US M (ACTUAL)

	1982	1983	% TOTAL	% CHANGE
DEFENCE (MILITARY)	20692	23468	53	+13.4
NASA	5981	6809	15	+13.9
AGRICULTURE	827	865	2	+4.6
AID	167	162	0.4	-2.9
TOTAL R & D	40039	44281		+10.6

TABLE 11

OFFICIAL DEVELOPMENT ASSISTANCE (ODA)

AS PERCENT OF GNP 1981

OPEC COUNTRIES	1.46
UK	0.44
CANADA	0.43
AUSTRALIA	0.41
JAPAN	0.26
USA	0.20

OECD COUNTRIES AVERAGE

1965	0.5
1981	0.32
ACCEPTED TARGET	0.7

TABLE 12

CROP GERMPLASM COLLECTIONS
HELD AT GENEBANKS MAINTAINED BY THE IARCs

CROP	ACCESSIONS	GENEBANK LOCATION
A. CEREALS		
RICE	60,000	IRRI
	8,226	WARDA
WHEAT	50,000	CIMMYT
	17,000	ICARDA
MAIZE	14,000	CIMMYT
SORGHUM	24,000	ICRISAT
BARLEY	13,000	ICARDA
	10,000	CIMMYT
PEARL MILLET	14,340	ICRISAT
MINOR MILLETS	3,700	ICRISAT

TABLE 13

CROP GERMPLASM COLLECTIONS HELD AT GENEBANKS MAINTAINED BY THE IARCs

CROP	ACCESSIONS	GENEBANK LOCATION
B. GRAIN LEGUMES		
COMMON BEAN	28,750	CIAT
MUNGBEAN	5,000	AVRDC
LIMA BEAN	2,300	CIAT
LENTIL	5,400	ICARDA
CHICKPEA	13,000	ICRISAT
	5,500	ICARDA
PIGEONPEA	8,850	ICRISAT
GROUNDNUT	8,800	ICRISAT
	2,500	IITA
FABA BEAN	3,000	ICARDA
COWPEA	12,000	IITA
C. ROOT AND TUBER CROPS		
CASSAVA	3,000	CIAT
	2,922	IITA
SWEET POTATO	1,000	AVRDC
	100	IITA
YAM	695	IITA
POTATO	13,000	CIP

TABLE 14

ENERGY IN LDC AGRICULTURAL PRODUCTION

	%
HUMAN	66
ANIMAL	26
MECHANICAL	8

COMMERCIAL ENERGY IN AGRICULTURAL PRODUCTION

RATIO PER CAPITA CONSUMPTION	
DC : LDC	18 : 1

	RATIO INPUT : OUTPUT
MAIZE (USA)	1 : 3
RICE (S.E. ASIA)	1 : 12

TABLE 15

MIXED FERTILIZERS

AVERAGE PRICE TO CARIBBEAN

BANANA GROWERS

$EC/TON ($EC 2 = $ CAN 1)

1972	185
1977	580
1981	1100

TABLE 16

ARABLE LAND

ANNUAL WORLD LOSS

	Ha X 10^6	
URBAN AND INDUSTRIAL SPREAD	7.0	(DC=3.0)
MINERAL EXPLOITATION	1.0	
EROSION	3.0	
DESERT SPREAD	2.0	
CHEMICAL DAMAGE (SALINITY, ETC.)	2.0	
TOTAL	15.0	

POTENTIAL CEREAL PRODUCTION FROM 15.0 M Ha

EQUIVALENT TO ENERGY NEEDS OF 68 M ADULTS.

ANNUAL AVERAGE POPULATION INCREASE TO

2000 AD = 70 M

TABLE 17

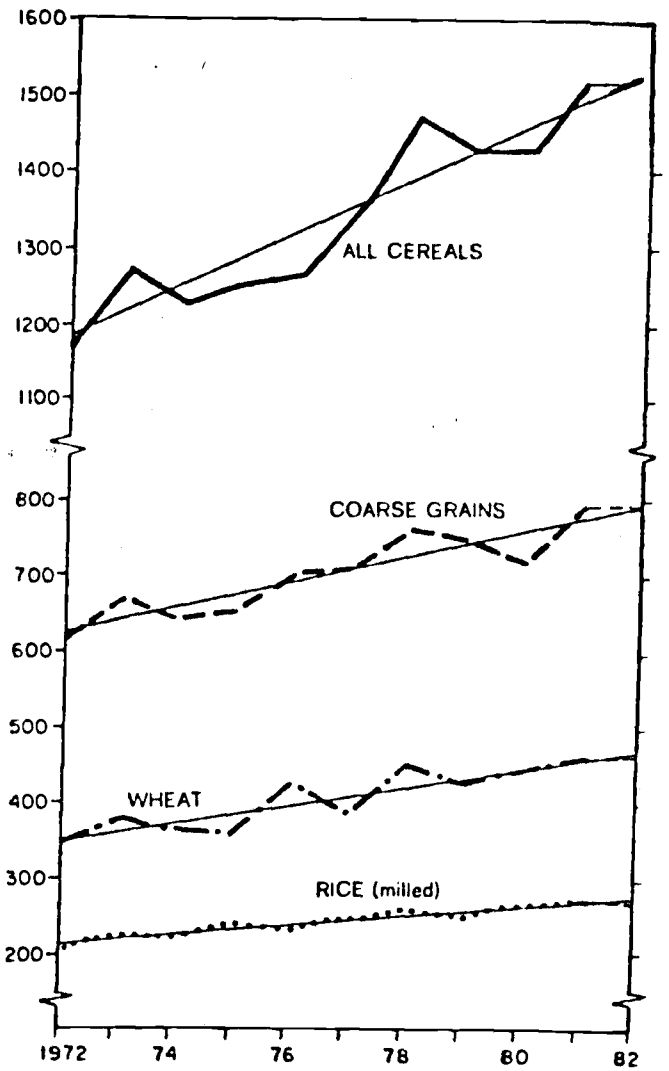
LAND USE IN AUSTRALIA	M.Ha
TOTAL AREA	750
TOTAL POTENTIAL AGRIC. LAND	77
FOOD CROPS	15
BARE FALLOW	4
SOWN PASTURE	26

(DATA FROM NIX 1976)

LAND USE IN CANADA	M.Ha
TOTAL AREA	920
ARABLE LAND	104
MARGINAL LAND	39
LAND SUITABLE FOR AGRICULTURE NOT CURRENTLY IN PRODUCTION:	
CROPLAND	9
MARGINAL CROPLAND	13
GRAZING LAND	18

(DATA FROM CANADA LAND INVENTORY 1976)

FIGURE 1



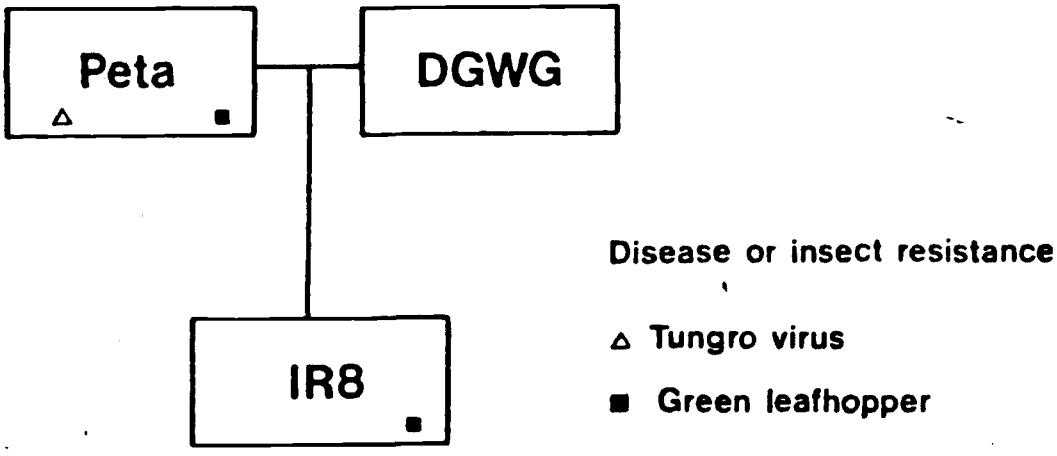
WORLD CEREAL PRODUCTION

ACTUAL AND 1970 - 1981 TREND

(MILLIONS OF TONS)

SOURCE FAO

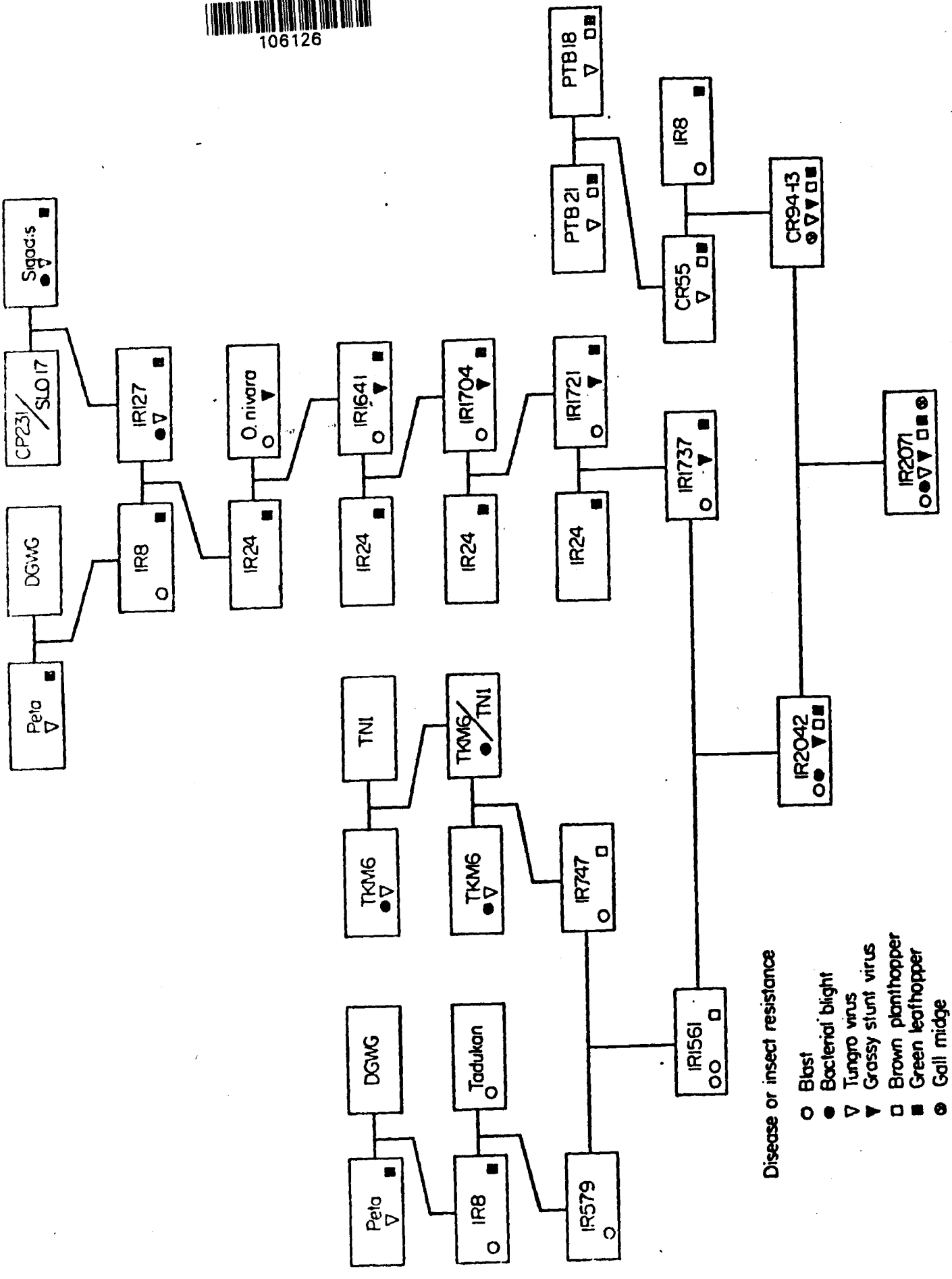
FIGURE 2



PEDIGREE OF IR8

SOURCE: IRRI

FIGURE 3



Pediqree of IR2071 (IR36)

SOURCE: IRRI